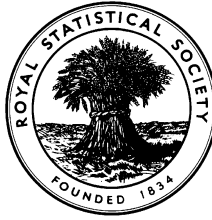


EXAMINATIONS OF THE ROYAL STATISTICAL SOCIETY



HIGHER CERTIFICATE IN STATISTICS, 2009

MODULE 7 : Time series and index numbers

Time allowed: One and a half hours

*Candidates should answer **THREE** questions.*

Each question carries 20 marks.

The number of marks allotted for each part-question is shown in brackets.

Graph paper and Official tables are provided.

Candidates may use calculators in accordance with the regulations published in the Society's "Guide to Examinations" (document Ex1).

The notation \log denotes logarithm to base e .

Logarithms to any other base are explicitly identified, e.g. \log_{10} .

Note also that $\binom{n}{r}$ is the same as nC_r .

This examination paper consists of 3 printed pages **each printed on one side only**.

This front cover is page 1.

Question 1 starts on page 2.

There are 4 questions altogether in the paper.

1.
 - (i) A time series can be decomposed into a number of components. List three such components and describe each one. (6)
 - (ii) Discuss the difference between additive and multiplicative seasonality. Explain how this difference affects the choice of model transformation when seasonal adjustment of the series involves a regression stage. (7)
 - (iii) How would you identify and remove the seasonal component for an additive model? (7)

2. Suppose you have fitted an ARIMA(1,0,1) model to a time series and you intend to implement a residual analysis in order to assess the model's fit.
 - (i) Write out the ARIMA(1,0,1) model for series X_t in terms of autoregressive parameters, differencing (if any), and moving average parameters. Hence obtain an expression for the residuals. (8)
 - (ii) Why and how would you use the correlogram of the residuals in order to assess the quality of the model? (6)
 - (iii) Describe other ways in which you could use residuals to assess model fit. (6)

3.
 - (i) Suppose you have data available for three periods (0, 1 and 2) from which you have calculated Laspeyres and Paasche price indices. Prove that the chain-linked Fisher price index (referenced to period 0 and linked at period 1) is the geometric mean of the chain-linked Laspeyres price index and the chain-linked Paasche price index (both being referenced to period 0 and linked at period 1). (5)
 - (ii) The following data show the sales of fruit produced by an orchard in 2007 and 2008.

<i>Fruit</i>	<i>2007 sales (£ thousand)</i>	<i>2008 sales (£ thousand)</i>	<i>Volume relative (2008 based on 2007)</i>
Apples	20	21	98.2
Pears	5	6	101.3
Plums	12	15	107.5

Calculate the following volume indices of the fruit production in 2008, using 2007 as base period.

- (a) Laspeyres
- (b) Paasche
- (c) Fisher
- (d) Geometric Laspeyres
- (e) Törnqvist

(3 marks for each)

4. (a) Suppose a group of people collect price and quantity data on food which they buy at a local market. One member of the group then constructs two series of price indices from these data, as shown in the following table.

<i>Period</i>	<i>Price index A</i>	<i>Price index B</i>
August 2008	100.0	100.0
November 2008	102.7	111.1
February 2009	96.2	114.8
May 2009	93.6	107.4

- (i) Given that one of A and B is a Laspeyres index and the other is a Paasche index, state with a reason which index is most likely to be which. (1)
- (ii) Calculate the Fisher price index for each of the 4 periods shown. (3)
- (iii) If there is no seasonality in the data from which indices A and B are constructed, what would be the anticipated effect of chain-linking on the Laspeyres index? (2)
- (b) The data in the table below relate to a car wash facility. The facility offered two types of wash (quick wash and full wash) in 2007. In 2008 the super wash was introduced as an additional service. Note that it is impossible to calculate a price relative for the super wash (if 2007 is the base period) because the 2007 price is undefined.

<i>Service</i>	<i>2007 sales (¥ million)</i>	<i>2008 sales (¥ million)</i>	<i>Price relative (2008 based on 2007)</i>
Quick wash	1.0	1.2	105.2
Full wash	0.8	0.7	102.7
Super wash		0.5	(undefined)

- (i) Calculate the Paasche price index for 2008 using 2007 as the base period. (3)
- (ii) The undefined price relative for the super wash service complicates the calculation of a Laspeyres price index for 2008 using 2007 as the base period. State how you would overcome this problem. (2)
- (iii) Calculate the Laspeyres price index for 2008 using 2007 as the base period. (3)
- (iv) Calculate the Paasche volume index for 2008 using 2007 as the base period. (6)